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MICHIGAN DEPARTMENT OF NATURAL RESOURCES

INTEROFFICE COMMUNICATION

March 8, 1990

RECEIVED
MAR 14 1990
WMD-PLAINWELL

TO: Tom Leep, WMD, Plainwell
Sue Peelen, ERD, Plainwell
Chris Waggoner, SWQD, Lansing

FROM: Steve Luzkow, Superfund Section, ERD

Subject: Preliminary Health Assessment-Allied Paper/Portage Creek/Kalamazoo River.

Under CERCLA, the Agency for Toxic Substances and Disease Registry (ATSDR) must conduct a health assessment for every site proposed for inclusion on the National Priorities List (NPL). It is used to evaluate current or potential risk to human health to determine if additional studies are necessary.. ATSDR is responsible for maintaining a national registry of effects of toxic substances and an inventory of literature research and studies of health effects and based on assessments, like the one attached, can conduct follow-up studies such as epidemiological studies.

Please review the attached health assessment and provide comments to me by March 23, 1990. MDPH is providing MDNR staff the opportunity to participate in a meeting involving the interdisciplinary team at MDPH on March 14, 1990. If you have an opportunity to review the document prior to March 14, 1990, and desire to attend the meeting at MDPH, then please contact John Filpus with MDPH at 517-335-9084. Please document and submit your comments to me. I will then be able to track MDPH's responses to comments submitted by each division.

Please feel free to call me at 5-3392 if you have any questions or need additional information.

cc: John Filpus, MDPH
Chris Flaga, ERD
James Linton, ERD

PRELIMINARY HEALTH ASSESSMENT
ALLIED PAPER/PORTAGE CREEK/KALAMAZOO RIVER
KALAMAZOO, KALAMAZOO COUNTY, MICHIGAN
MID006007306
WORKING DRAFT
March 7, 1990

prepared by
Interagency Center on Health and Environmental Quality (ICHEQ)
Michigan Department of Public Health (MDPH)
under a cooperative agreement
contract # U50/ATU500003-02 with
Office of Health Assessment
Agency for Toxic Substances and Disease Registry (ATSDR)

SUMMARY

The Allied Paper/Portage Creek/Kalamazoo River site has been proposed for the United States Environmental Protection Agency (USEPA) National Priorities List (NPL). The site consists of the Allied Paper, Inc., Residual Disposal Area, covering 75 acres in Kalamazoo, Michigan, Portage Creek from there to its confluence with the Kalamazoo River, and thirty-five miles of the Kalamazoo River, from Portage Creek downstream to Lake Allegan. Extensive contamination with polychlorinated biphenyls (PCBs) has been found in the water, sediments, and fauna of the river and the creek since 1971. Four impoundments on the river or creek in the site area have been drawn down, exposing contaminated sediments. A number of remediation actions are in planning or process in the site area. The site is of potential human health concern due to the threat to health from consumption of contaminated water and river fauna and contact with contaminated sediments. In addition, abandoned structures on the site and other features of

the terrain, in the absence of effective restriction of access, present a physical hazard to trespassers.

BACKGROUND

The Allied Paper/Portage Creek/Kalamazoo River site has been proposed for the United States Environmental Protection Agency (USEPA) National Priorities List (NPL).

A. Site Description and History

The Allied Paper/Portage Creek/Kalamazoo River site includes the Allied Paper, Inc., Residual Disposal Area in Kalamazoo, Michigan (described in detail below), Portage Creek north of Alcott Street to its confluence with the Kalamazoo River, and thirty-five miles of the river itself downstream (north) from Portage Creek, to the inlet to Lake Allegan, including the beds of a number of impoundments that have been drained. There are a number of other potential sources of contamination along the river and in its watershed, both within the site area and upstream.[1] These may be included within the site remediation or treated separately, as appropriate. The Kalamazoo River downstream through Lake Allegan

[1] The MDNR Proposed Priority Lists of Environmental Contamination Sites under Michigan Act 307 listed 57 other sites in Kalamazoo County and 32 in Allegan County as of November 1988. Five of these are also on or proposed for the USEPA's NPL.

to the river mouth at Saugatuck, Michigan, on Lake Michigan, is also being studied regarding the effects of the upstream contamination.

The Allied Paper, Inc., Residual Disposal Area is located in the south of the City of Kalamazoo, Michigan. It covers a roughly 75 acre area, bounded by Alcott Street to the north, the Conrail tracks to the west, Cork Street to the south, and the high water mark on the east bank of Portage Creek to the east. Portage Creek flows south to north along the east side of the site. A dam at Alcott Street formerly created a series of impoundments in the creek, the Bryant Mill Ponds. The upper and lower ponds were separated by a now-abandoned causeway. The sluice gate in the dam has been open since 1976, and the ponds have drained. The former pond beds are part of the site.

A paper plant north of Alcott Street, currently owned by Performance Paper, who bought it from Allied Paper, Inc., disposes of waste from their operation in the southern section of the site, as has been done for decades. Use of the disposal area has been cut back drastically due to changes in paper processing methods and to declining operations at the plant. When the plant was in full operation, slurried wastes from their paper recycling process were pumped to a settling tank at the highest point of the site. After settling out, the solids were transferred to a

pair of lagoons for further settling. The liquids were pumped off into a series of ponds, partitioned by dikes, and thence to the City of Kalamazoo sewer system, while the dewatered solids were placed into a landfill on the site. Depending on the quantity of waste and the permits the company could obtain, the liquids have also been recycled through their system or discharged into Portage Creek.

The currently active landfill covers 7.8 acres of the site. Renewal of the company's license to operate the landfill was denied by the Michigan Department of Natural Resources in May 1987 due to the detection of PCBs in the groundwater at the site, attributed to the activities at the site, and other alleged violations of the terms of the operating license. A Partial Consent Order issued by the Federal District Court allows the landfill to remain in operation until it is full. The company is building dikes across the settling ponds, and intends to stabilize the sediments in the ponds with construction waste as each section is diked off. Cattails and other swamp plants are growing in the settling ponds.

There are borrow pits for the landfill operation along the west side of the site.

A second paper mill, formerly located south of Cork Street, also used the disposal area. A settling tank from their operation still remains at the south end of the site, and is used as a holding tank.

Much of the northern section of the site was sold, by Allied Paper or one of its predecessors, to the Panelite company, who operated a plant there, though there is reportedly some dispute concerning the title. Operations have long since ceased, though the buildings remain, partially dismantled and covered with graffiti. The City of Kalamazoo had the first floor walls of the buildings removed, terming the buildings an attractive nuisance.

Stryker Surgical Supplies owns and operates a facility on former Allied Paper land on the east side of Portage Creek, at Alcott Street. Their lot line extends to the middle of the creek.

The impoundments behind the Plainwell, Otsego, and Trowbridge dams on the Kalamazoo River have been drained. The superstructures of the dams have been removed.

Polychlorinated biphenyls (PCBs) were first identified in the water, sediments, and fish of the Kalamazoo River and Portage Creek in 1971. Since then, a number of studies and remedial actions have been carried out in the area. Remediation of the

contaminated sediments in the former impoundments on the Kalamazoo River is currently in the planning and permitting stage. The State of Michigan filed suit in December 1987 against Allied Paper, Inc., its parent company, SCM Corp., and other Potentially Responsible Parties (PRPs) concerning the PCB contamination of the Bryant Mill Ponds. Litigation is still in process in this and related cases. The Allied Paper/Portage Creek/Kalamazoo River site was proposed in 1989 for inclusion on the USEPA's National Priorities List (NPL).

B. Site Visit

MDPH and MDNR personnel toured the Allied Paper site with a representative of the company on February 26, 1990. They were given a summary of company waste disposal procedure and driven around the site. The MDPH and MDNR personnel then visited the sites of two of the dams on the Kalamazoo River.

C. Community Health Concerns

Due to PCB contamination, the MDPH first issued an advisory concerning consumption of fish from the Kalamazoo River and Portage Creek in 1977. The present advisory as applied to the surface waters in the vicinity of the site is that carp, catfish, suckers and largemouth and smallmouth bass taken from Portage

Creek below Monarch Mill Pond (upstream of the Allied Paper site) and the Kalamazoo River from Morrow Pond Dam (upstream of Kalamazoo) to Allegan Dam (the outlet of Lake Allegan) should not be eaten. Consumption of all other species taken from these waters should be restricted to no more than one meal per week, and nursing, expectant, and intending mothers and children age 15 and younger should not eat any of these fish. Downstream from Allegan Dam on the Kalamazoo River, the advisory is that carp, catfish, and northern pike longer than 25 inches should not be eaten, and smaller pike, largemouth bass longer than 15 inches, and smallmouth bass should be eaten no more than one meal a week, with the sensitive populations mentioned above advised not to eat fish of these species and sizes from the river at all.

DEMOGRAPHICS, LAND USE, AND NATURAL RESOURCE USE

The Allied Paper site lies within the city of Kalamazoo (pop. 80,000), and Portage Creek flows through the city from the Allied Paper site to the river. The Kalamazoo River in the site area flows through the cities of Kalamazoo, Plainwell (pop. 3,800), Otsego (4,000), and Allegan (4,700). Major areas of these cities lie within three miles of the site area, with the facilities needed to support their populations. On the periphery of the site, or indirectly affected, are the city of Portage (pop.

40,000) south of Kalamazoo, and the cities of Saugatuck (1,100) and Douglas (950) flanking the Kalamazoo River near its mouth.

Most of the land east of Portage Creek at the Allied Paper site is residential. That across the railroad tracks from the site to the west is mainly industrial and commercial. North is industrial, south is mixed light commercial and residential.

Land use along the river in the site area includes urban commercial and industrial; urban, suburban, and rural residential; agricultural; and recreational. The river itself is used for swimming, boating, and fishing. The western half of Lake Allegan and some ten miles of the Kalamazoo River below the lake are within the Allegan State Game Area.

ENVIRONMENTAL CONTAMINANTS AND OTHER HAZARDS

A. On-Site Contamination

The primary contaminants present at the Kalamazoo River site are polychlorinated biphenyls (PCBs). PCBs have been found in the water, sediment, and fish of Portage Creek and the Kalamazoo River, including the sediment now exposed in the drained impoundments of Bryant Mill Ponds and Plainwell, Otsego, and Trowbridge dams. Table 1 lists selected water, sediment, and

fish concentrations of total PCBs reported within the main study area, between Bryant Mill Ponds and Lake Allegan. The values listed are maximums in the medium at or near the location around the time given. Maxima for surface sediment concentrations are given for cases in which the maxima for all sediment concentrations were from borings, at the depth given. The total mass of PCBs in the sediments has been estimated at 230,000 pounds.

There were reportedly PCB oil spills around the Panelite works, and allegedly poor procedures used during a clean-up project. A number of small, apparently independent, contamination plumes have been found in the groundwater under the Allied Paper site. A plume containing pentachlorophenol (88 parts per billion [ppb]), ethylbenzene (32 ppb), toluene (4.7 ppb), and xylenes (148 ppb total) has been linked to a separate site to the west of the Allied Paper site, which is being remediated under MDNR oversight. Other groundwater contaminants include tetrachloroethylene, found in three adjacent wells at up to 30 ppb.

A pair of groundwater seeps were found in late 1985 on the bank of the creek, one of which contained up to 4,389 parts per trillion (ppt) PCBs, the other up to 51. The surface soils near the first seep contained up to 260 parts per million (ppm) PCBs.

The first seep hasn't flowed since late 1986, and the second hasn't shown any contamination since late 1985. A seep with extremely high metals concentration, e.g. 162 ppb chromium, 50,400 ppb aluminum, 134 ppb nickel, and 161,000 ppb iron, was inadvertently created during investigatory activities.

B. Off-Site Contamination

Table 2 lists selected water, sediment, and fish concentrations of total PCBs reported downstream of the main study area.

C. Quality Assurance and Quality Control

In preparing this Health Assessment, MDPH relied on the information provided in the referenced documents and assumed that adequate quality assurance and quality control measures were followed with regards to chain-of-custody, laboratory procedures, and data reporting. The validity of the analysis and conclusions drawn for this Health Assessment is determined by the reliability of the referenced information.

D. Physical and Other Hazards

The south boundary of the Allied Paper site is fenced, as is the area around the settling tank, and much of the site is posted,

warning against trespass due to unstable land, but there is little to inhibit access to the rest of the site, or to the bottom lands along the Kalamazoo River. The former Panelite building is decrepit, and freely accessible. Anyone trespassing would be in danger should part of it fall on them or collapse under them. The former lagoons and ponds are swampy, and the ground may give way unexpectedly underfoot. There are also many steep banks, to the creek or former pond bottom, and into the borrow pits. The only solid ground in the lagoon and settling pond area is on the narrow dikes separating the settling ponds.

PATHWAYS ANALYSES

A. Environmental Pathways (Fate and Transport)

PCBs form a class of some 209 closely related compounds, or congeners. They are highly stable and resistant to degradation, so they persist in the environment. They are hydrophobic and bind strongly to soils. Hence, leaching to groundwater should be minimal and PCBs in surface water will tend to adsorb to sediments. The presence of organic solvents may mobilize PCBs in soil and increase leaching, but volatile organic chemicals have not been commonly found in soils or sediments at the site. PCBs may also volatilize from surface water, though their vapor pressures are very low at normal temperatures. Due to their high

solubility in organic materials and low solubility in water, PCBs bioaccumulate strongly.

In the drained impoundments, the Bryant Mill Ponds, Plainwell, Otsego, and Trowbridge dams, the contaminated sediments outside the current channel no longer continuously contribute to the PCBs content of the water. However, erosion and flooding periodically release PCBs from these sediments to the water.

Carp and other bottom-feeding fish may disturb contaminated sediments. This may increase the water burden as suspended particles may carry contaminants and the increased contact area will increase the rate of solution of soluble contaminants. Lake Allegan has a large carp population.

B. Human Exposure Pathways

The potential pathways for human exposure to the contaminants at this site include: for surface and groundwater, ingestion and dermal contact and inhalation of volatile contaminants secondary to household use; for soil and sediment, ingestion and dermal contact; inhalation of volatile contaminants; and ingestion of contaminated biota.

Groundwater is the main source for potable water in the area. Five City of Kalamazoo municipal well fields are within one mile of the Allied Paper site, four to the north or northwest, and one to the southeast, and four more are within three miles to the southeast. The groundwater at the Allied Paper site flows to the northeast, converging toward and discharging into Portage Creek. This should carry the identified groundwater contaminants away from these wells and keep them from reaching any other, since there are no producing wells on the site. In addition, the PCBs found in the groundwater at the site were found in a monitoring well whose screen was within the Bryant Mill Ponds sediment bed or in seeps in a region of contaminated surface soil. Deeper or upgradient monitoring wells showed no PCB contamination. It is arguable that the detected groundwater contamination may have been due to the water picking up PCBs from the surrounding soil at the point of sampling.

As the PCBs elsewhere along the river are mainly found in river sediments, any PCBs that might be leached into the groundwater will flow mainly to the river except in areas where aquifers recharge from the river. As mentioned above, PCBs tend to bind to soil and sediment, reducing the extent of water contamination.

Surface water is not used for potable water in the area. There are industrial and agricultural intakes on the river. The

Performance Paper (former Allied Paper) plant has a process water intake on Portage Creek, at the south (upstream) end of the Allied Paper site. People swim, boat, and fish on the river, incurring dermal contact with and incidental ingestion of the water.

Swimming, fishing, and boating on the river can also lead to dermal contact with contaminated bottom sediments.

The fish consumption advisory is not legally binding, and the possibility of an angler disregarding the advisory and frequently consuming fish from the river with high PCB content cannot be ruled out.

Access to the Allied Paper site is not effectively restricted, and there is evidence of past trespass. Young people reportedly operate all-terrain vehicles on the site. Much of the site is posted, warning of unstable land, though only limited areas are fenced. Contact with and incidental ingestion of contaminated soils is likely to occur with access to the site. Access to the former impoundments along the river is not effectively restricted, raising the same possibility.

PUBLIC HEALTH IMPLICATIONS

The polychlorinated biphenyls (PCBs) are a group of 209 related compounds (or congeners) that have been produced commercially in mixtures with various chlorine percentages. Animal studies have shown that some PCB mixtures can produce adverse health effects including liver damage, skin irritation, reproductive and developmental effects, and cancer. Exposure has led to chloracne and rashes in occupational settings. There is limited evidence that occupational exposure to PCBs may be related to reproductive and developmental effects and liver cancer. The specific congeners involved in the health effects have not been identified. More important, the exact composition of any sample PCB mixture may not be known. Even different batches made to meet the same specifications and sold under the same designation may vary significantly in composition. Therefore, common health advisories and regulations for all PCBs are the rule. All PCBs and mixtures are classified as probable human carcinogens (USEPA Class B2), based on the animal studies and limited human evidence mentioned above.

The water concentrations of PCBs found in the Kalamazoo River and Portage Creek are much above the Ambient Water Quality Criteria for surface water issued by the USEPA . They are of the same order of magnitude as the Criteria for drinking water only,

depending on which cancer risk level is considered. The surface water concentrations are below a proposed Maximum Contaminant Level for the chemicals.

As mentioned above, it is arguable that the detected groundwater contamination may have been due to the water picking up PCBs from the surrounding soil at the point of sampling. The pentachlorophenol and aromatic compounds found in the groundwater at the Allied Paper site can be attributed to an off-site source, which is in the process of being remediated. The tetrachloroethylene found may be due to a local, transient event. The high metals content in the third groundwater seep is not obviously related to any activity on the site. The groundwater at the Allied Paper site is not used and discharges to Portage Creek, so these deviations from drinking water standards in the groundwater pose no current health risk. The seep, if still active, may pose a hazard due to the chance for dermal contact or ingestion by people on the site.

CONCLUSIONS

Based upon information reviewed, this site is of potential public health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects. As noted in the Pathways

Analysis Section above, human exposure to PCBs may be occurring and may have occurred in the past via contact with contaminated soils, contact and ingestion of contaminated water, and ingestion of contaminated biota.

RECOMMENDATIONS

Access to the Allied Paper site should be further restricted. Specifically, the east bank of Portage Creek should be fenced, because of both the contamination in the sediments in the Bryant Mill Ponds bed and the physical hazard posed by the steep bank to wandering children. Access to the Panelite building, and to the areas of reported PCB spills, should also be better restricted.

The MDPH supports the planned and intended remediation of the sediments in the Bryant Mill Ponds and the impoundments on the Kalamazoo River. Due care should be taken, as always, in the planning and design to ensure the effectiveness of the remediation and in its execution to protect public health, workers, and the environment.

Groundwater in the area of detected tetrachloroethylene contamination should be further studied to determine the source, extent, and proper remediation of the contamination.

In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended, this site has been evaluated for appropriate follow-up with respect to health effects studies. Although there are indications that human exposure to on-site/off-site contaminants may currently be occurring and may have occurred in the past, this site is not being considered for follow-up health effects studies at this time because the population subject to significant exposures cannot be readily identified and located.

PREPARERS OF REPORT

John W. Filpus, Environmental Engineer

REFERENCES

Tom Flanagan, former Allied Paper, Inc., Vice President.

MDNR District 12 staff.

MDNR files.

Wilkins & Wheaton Environmental Services, "Addendum I to the Hydrogeologic Investigation for the Allied Paper, Inc., Sanitary Landfill, Kalamazoo, Michigan," October 1988.

Michigan Department of Natural Resources (MDNR), "Kalamazoo River Remedial Action Plan, Second Draft," December 1987.

MDNR Surface Water Quality Division, "Fish Contaminant Monitoring Program 1989 Annual Report," December 1989.

ATSDR, "Toxicological Profile for Selected PCBs (Aroclor-1260, -1254, -1248, -1242, -1232, -1221, and -1016)," ATSDR/TP-88/21, June 1989.

Peterson, Gregory W., to Jon F. DeWitt, Memorandum re: 1988 Portage Creek Sediment Survey Laboratory Reports, Limno-Tech, Inc., September 15, 1988.

Limno-Tech, Inc., "HM Holdings/Allied Paper, Inc.: Results of the Stream Diversion Design Studies, Portage Creek in Bryant Mill Pond," February 15, 1990.

Limno-Tech, Inc., and United Environmental Technologies, "Report on the H.M. Holdings/Allied Paper Investigations of the Historical Residuals Dewatering Lagoons and 'Seeps 1 and 2'," January 1990.

United Environmental Technologies, "Addendum II to the Hydrogeologic Investigation for the Allied Paper, Inc., Sanitary Landfill, Kalamazoo, Michigan," January 31, 1990.

Table 1. Selected total PCBs concentrations found in the Allied Paper/Portage Creek/Kalamazoo River site

Location[b]	Medium	Date	Concentration (ppm)
Allied Paper Landfill (MW-5)	groundwater	5/6/88	790 ppt
	soil (6-7')	6/15/88	0.08
	waste (14')	1989	1,200
Bryant Mill Ponds	sediment	1972	368.7
		11/2/83	582
		4/3/84	898
		10/15/85	530
		8/6/86	980
		1987	74
	(1-2')	6/22/88	1,000
	(surface)	6/24/88	440
	groundwater	10/4/89	70 ppt
	soil (10')	8/3/89	3.3
	fish		
	carp	7/85	4.50
		7/86	27.37
		7/14/87	5.5
PC - Alcott St.	water	5/6/85	283 ppt
		7/29/85	335 ppt
PC - Lake St.	sediment	1972	117.61
PC - Vine St.	sediment	8/76	55.58
	fish		
	carp	9/81	1.
	wh. sucker	9/81	7.6
PC - Michigan Ave.	sediment	8/76	0.5
		11/82	85
		11/83	15
KR - Paterson Ave.	water	10/15/85	42 ppt
		6/24/86	37 ppt
	sediment	11/82	57
		1984	13
KR - Mosel Ave.	water	6/24/86	44 ppt
		3/24/87	41 ppt

[b] PC - Portage Creek
KR - Kalamazoo River

Table 1. (cont.)

KR - Mosel Ave.	fish		
	carp	7/71	164.5
		6/76	8
		9/81	7.7
		7/83	6.53
		7/85	10.8
		7/86	11.09
	sm. bass	9/81	2.13
		7/85	1.89
	wh. sucker	7/71	56.89
KR - D Ave.	water	5/20/87	30 ppt
	sediment	8/9-10/76	10.3
		11/82	1.6
KR - 10th St.	water	7/22/85	110 ppt
		5/13/86	153 ppt
		5/20/87	97 ppt
KR - Plainwell Dam	water	5/20/85	62 ppt
		5/13/86	91 ppt
	sediment	11/83	55.9
	fish		
	carp	7/71	22.31
		6/76	13.8
		9/81	9.2
		7/83	15.9
		7/85	12.5
		7/86	9.46
		7/14/87	17.12
	wh. sucker	7/71	21.25
		8/76	4.3
KR - Otsego	sediment	1987	120
KR - M-89	sediment	8/76	66.6
		1982	27
KR - Otsego Dam	water	4/18/85	122 ppt
	sediment	5/29/85	57
	fish		
	carp	7/71	58.72
		8/76	11.8
	sm. bass	8/76	1.5
	wh. sucker	7/71	12.68
		8/76	4.
	ducks	8/85	4.8

Table 1. (cont.)

KR - Farmer St.	water	7/22/85	90 ppt
KR - Trowbridge Dam	sediment	6/83	81
	(14-18")	11/83	50.9
	(surface)	11/83	44.2
	fish		
	carp	7/71	4.06
	wh. sucker	7/71	12.14
	nor. pike	7/71	8.22
	ducks	8/85	1.9
KR - 26th St.	water	4/18/85	126 ppt
KR - Williams Rd.	water	4/18/85	119 ppt
KR - Allegan	sediment	8/9-10/76	24.67
	(5')	5/29/85	57.4
	(surface)	5/29/85	47.3
KR - M-118	water	6/24/85	193 ppt
		5/13/86	149 ppt

Table 2. Selected total PCBs concentrations found in the Kalamazoo River outside of the site area

Location	Medium	Date	Concentration (ppm)
Lake Allegan	sediment	8/9-10/76	24.67
		11/83	41.7
		1987	14
	fish		
	carp	7/71	7.32
		8/76	7.4
		9/81	47
		7/83	5.03
		7/85	14
		7/86	13.34
		7/14/87	6.14
	bass	8/76	2.4
		9/81	2.2
		7/85	6.54
	sm. bass	7/14/87	5.14
	nor. pike	7/71	13.44
		8/76	2.1
		7/14/87	3.09
	wh. sucker	7/71	13.77
		8/76	7.4
	bullhead	7/71	10.65
Below Allegan Dam	water	5/29/85	152 ppt
		5/13/86	174 ppt
Allegan State Game Area	duck	8/85	1.5
	swan eggs	1986	1.6
Koopman Marsh	sediment	1/85	1.11
Kalamazoo River	sediment	6/85	1.4
New Richmond	water	4/15/82	79 ppt
U.S.-31	water	4/15/82	121 ppt
		7/22/85	60 ppt
		5/13/86	103 ppt
Saugatuck	sediment	1982	1.74
	water	1971-2	65 ppt
		11/6/80	70 ppt
		5/15/81	90 ppt
		4/15/82	98 ppt

Table 2. (cont.)

Saugatuck	fish		
	carp	7/71	45.4
		7/76	36.
		5/78	231
		9/81	16
		7/83	25.7
		7/85	9.12
		7/86	8.99
		7/13/87	8.64
	bass	7/76	34.1
		9/81	15
		7/85	2.97
	lm. bass	3/31/87	2.02
	rock bass	7/71	10.1
		3/31/87	0.52
	nor. pike	7/71	8.7
		8/76	4.7
		5/78	10.9
		9/81	0.9
		3/31/87	3.36
	wh. sucker	7/71	45.5
		5/78	6.4
		3/31/87	2.82
	ducks	8/85	1.9